

## Cursors: Tools for Measuring Signal Values

Cursors are basic, important tools for measuring signal values.



In Standard Display Mode, **Amplitude**, or **Voltage**, cursors — broken lines or bars running across the screen — are moved up and down the grid *pixel by pixel*.

**Time** cursors — arrows or cross-hair markers that move along the waveform (see *symbols*) — can be placed at a desired time to read the amplitude of a signal at that time, and moved to *every single point acquired*.

When a Time cursor is placed on a data point, a cross-bar appears at the tail of the arrow, and at top and bottom of the cross-hair marker.

In **Absolute** Mode a single cursor is controlled. Readings for amplitude (using Amplitude cursors) or time and amplitude (using Time cursors) can be displayed at the cursor location. Measured amplitudes are relative to ground; measured times to the trigger point.

In **Relative** Mode, a pair of Amplitude or Time cursors is controlled, providing readings on the difference between the two in amplitude, or time and amplitude, respectively.

Amplitudes are shown in the Trace Label for each trace. When Time cursors are used, the time is shown below the grid. And in Relative Mode the frequency corresponding to the time interval between the cursors is also displayed there.

When there are few data points displayed, Time-cursor positions are linearly interpolated between the data points. Time cursors move up and down along these straight-line segments.

### Cursors and Persistence

When using Persistence, Amplitude cursors are the same as in Standard Display (see *above*). Time cursors are vertical bars running down the screen and moving across it.



## CURSORS/MEASURE & Parameters

### Cursors in XY Display

In XY Display, Absolute-Amplitude cursors are horizontal and vertical bars that can be moved both up and down and from side-to-side across the screen. Relative-Amplitude cursors are pairs of bars that move in the same way. Absolute- and Relative-Time cursors behave as they do in Standard Display.

Combinations of the amplitude values are shown on the left-hand side of the grid in the following top-to-bottom order:

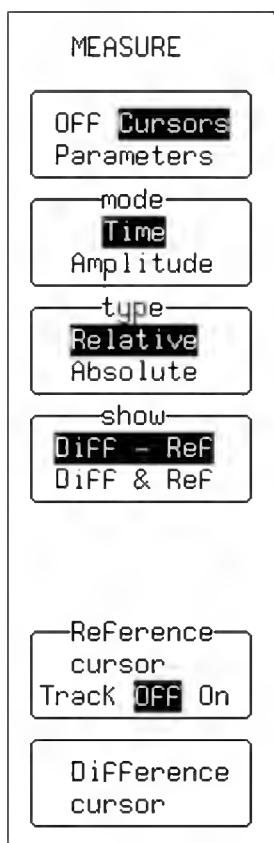
1. “ $\Delta Y$  value /  $\Delta X$  value” ..... Ratio
2. “ $20 * \log 10$  (ratio)” ..... Ratio in dB units
3. “ $\Delta Y$  value \*  $\Delta X$  value” ..... Product
4. “ $f = \arctan (\Delta Y / \Delta X)$   
range  $[-180^\circ$  to  $+180^\circ]$ ” ..... Angle (polar)
5. “ $r = \sqrt{(\Delta X * \Delta X + \Delta Y * \Delta Y)}$ ” ... Radius (distance to origin).

The definition of  $\Delta X$  and  $\Delta Y$  depends on the cursor used. The table below shows how  $\Delta X$  and  $\Delta Y$  are defined for each type of measurement.

Cursors					
	A <sub>Abs</sub>	A <sub>Rel</sub>	T <sub>Abs</sub>		T <sub>Rel</sub>
			Org = (0,0)	Org = V <sub>xOffset</sub> V <sub>yOffset</sub>	
D <sub>X</sub>	V <sub>xRef</sub> - 0	V <sub>xDif</sub> - V <sub>xRef</sub>	V <sub>xRef</sub> - 0	V <sub>xRef</sub> - V <sub>xOffset</sub>	V <sub>xDif</sub> - V <sub>xRef</sub>
D <sub>Y</sub>	V <sub>yRef</sub> - 0	V <sub>yDif</sub> - V <sub>yRef</sub>	V <sub>yRef</sub> - 0	V <sub>yRef</sub> - V <sub>yOffset</sub>	V <sub>yDif</sub> - V <sub>yRef</sub>

WHERE:

A <sub>Abs</sub>	Absolute Amplitude cursors	V <sub>xRef</sub>	Voltage of the Reference cursor on the X trace
A <sub>Rel</sub>	Relative Amplitude cursors	V <sub>yRef</sub>	Voltage of the Reference cursor on the Y trace
T <sub>Abs</sub>	Absolute Time cursors	V <sub>xDif</sub>	Voltage of the Difference cursor on the X trace
T <sub>Rel</sub>	Relative Time cursors	V <sub>yDif</sub>	Voltage of the Difference cursor on the Y trace
Org	Origin		

**MEASURE — Cursors**

Press  — to access the “MEASURE” Setup menus.

**Off/Cursors/Parameters**

To select “Cursors”.

**mode**

For selecting “Time” (time or frequency cursors) or “Amplitude” (voltage or amplitude cursors).

**type**

To toggle between “Relative” and “Absolute”. The first displays two cursors, Reference and Difference, and indicates either the voltage or time and voltage between the two. The second shows a single cursor that indicates either voltage compared to ground level, or this and time compared to the trigger point.

**show**

To select: “Diff – Ref”, which shows the subtraction between difference- and reference-cursor amplitudes; or “Diff & Ref”, which displays the amplitude values for each cursor. *Not available in persistence mode.*

**Reference cursor**

To control the Reference cursor available with Relative cursors, using the associated menu knob. With “Track” “ON”, both Reference and Difference cursors are controlled by this knob and move together, a constant time or voltage interval maintained between them. This tracking interval is represented by a bar — horizontal for time; vertical for voltage — appearing, respectively, at the top and left-hand edge of the grid.

**Difference cursor**

For controlling the Difference cursor, available when “Relative” is selected from “type” (see above), using the associated menu knob.

**Cursor position (not shown)**

For controlling the Absolute cursor, available when “Absolute” is selected from “type” (see above), using the associated menu knob.

# Parameters: Automatic Measurements

The instrument can determine certain signal properties automatically, using signal parameters. *The scope's standard parameters are listed and described in Appendix D of this manual.*<sup>\*</sup>

For common measurements on a lone signal, parameters can be measured in either of two standard classes or modes: in the amplitude or time domain.

On different signals, they can be customized and used to determine up to five of the quantities on the parameter list. Customized parameter measurements can also be used for Pass/Fail testing against chosen limits (see page 14-13).

Statistics on the parameter values are accumulated and can be displayed for all modes.

In addition to the overall number of sweeps used, each parameter has its average, lowest and highest value. The standard deviation of the parameter is also calculated.

### Parameter Symbols

The algorithms that determine pulse waveform parameters are able to detect those situations where the mathematical formulas may be applied. However, the results obtained should be interpreted with caution. In such cases, the scope displays the name of the parameter and its value are separated on the screen by a graphic symbol, which acts either as information on the parameter or as a warning. The following table explains these symbols.

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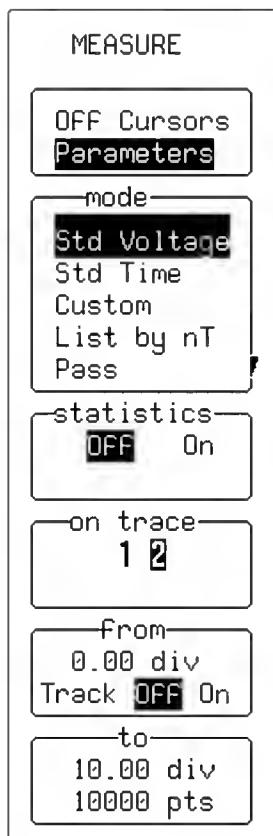
<sup>\*</sup> A wide range of additional parameters are available in the specialized software packages, such as WP03, described in those packages' operator's manuals

<b>Information</b>	
	The parameter has been determined for several periods (up to 100), and the average of those values has been taken.
	The parameter has been determined over an integral number of periods.
	The parameter has been calculated on a histogram.
	Insufficient data to determine the parameter.
<b>Warnings</b>	
	Amplitude histogram is flat within statistical fluctuations; minimum and maximum are used to assign top and base.
	Only an upper limit could be estimated (the actual value of the parameter may be smaller than the displayed value).
	The signal is partially in overflow.
	The signal is partially in underflow.
	The signal is partially in overflow and in underflow.



## CURSORS/MEASURE & Parameters

### MEASURE — Parameters — Standard Voltage



This mode measures, for a single trace:

- Peak-to-Peak (amplitude between maximum and minimum sample values)
- Mean of all sample values (corrected for periodic signals)
- Standard Deviation
- Root Mean Square of all sample values (corrected for periodic signals)
- Amplitude of the signal.

#### Off/Cursors/Parameters

To select “Parameters”.

#### mode

To select “Standard Voltage” parameters.

#### statistics

For turning “On” display of the parameter’s average, lowest, highest, and standard deviation, as well as the number of sweeps included in the statistics — cleared each time the acquisition conditions change or when the CLEAR SWEEPS button is pressed. As long as “Parameters” is highlighted in the top menu, the accumulation of statistics continues, even if the statistics are not shown.

#### on trace

To select the trace for which the voltage parameters are measured. The choices available in this menu will depend on the traces displayed (a maximum of four traces can be displayed). Here, Traces 1 and 2 are displayed and “2” selected.

#### from

To determine the starting point, in screen divisions, for parameter measurements, using the associated menu knob. “Track” “On”, links control of both the starting and end points of the parameter measurement so that they can be moved together using the associated menu knob.

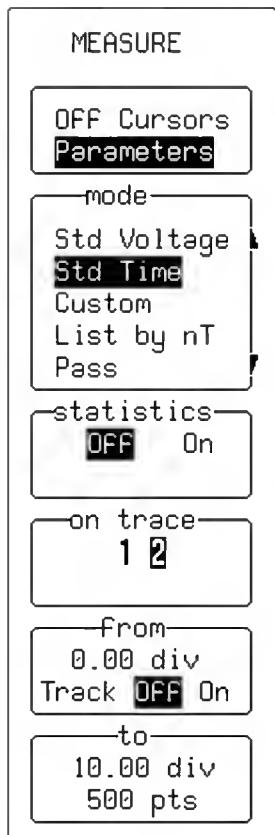
#### to

To determine the end point in screen divisions. Also indicates the total number of data points used for the measurements.

## MEASURE — Parameters — Standard Time

This mode measures for a single trace:

- Period
- Width (at 50% amplitude)
- Rise time (10–90% of amplitude)
- Fall time (90–10% of amplitude)
- Delay (from trigger to first 50% amplitude point).



### Off/Cursors/Parameters

To select “Parameters”.

#### mode

For selecting “Standard Time” parameters.

#### statistics

For turning “On” display of the parameter’s average, lowest, highest, and standard deviation, as well as the number of sweeps included in the statistics — cleared each time the acquisition conditions change or when the CLEAR SWEEPS button is pressed.

As long as “Parameters” is highlighted in the top menu, the accumulation of statistics continues, even if the statistics are not shown.

#### on trace

For selecting the trace for which the time parameters are to be measured. The choices available in this menu will depend on the traces displayed (a maximum of four traces can be displayed). Here, Traces 1 and 2 are displayed and “2” selected.

#### from

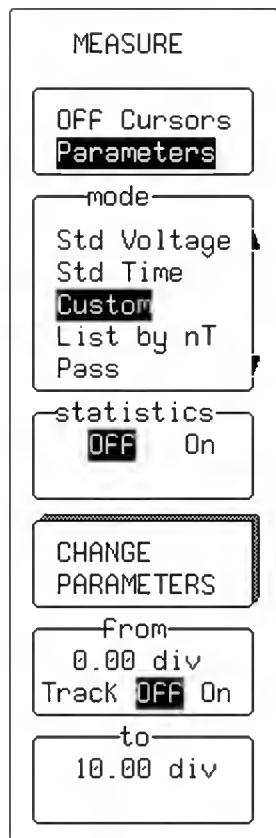
To determine the starting point, in screen divisions, for parameter measurements. “Track” “On”, links control of both the starting and end points of the parameter measurement so that they can be moved together using the associated menu knob.

#### to

To determine the end point in screen divisions. Also indicates the total number of data points used for the measurements.

### MEASURE — Parameters — Custom

In this mode, up to five parameters can be displayed for various traces.



#### Off/Cursors/Parameters

For selecting “Parameters”.

##### mode

To select “Custom” parameters.

##### statistics

For turning “On” display of the parameter’s average, lowest, highest, and standard deviation, as well as the number of sweeps included in the statistics — cleared each time the acquisition conditions change or when the CLEAR SWEEPS button is pressed.

As long as “Parameters” is highlighted in the top menu, the accumulation of statistics continues, even if the statistics are not shown.

#### CHANGE PARAMETERS

For accessing the secondary “CHANGE PARAM” menu (see following pages).

##### from

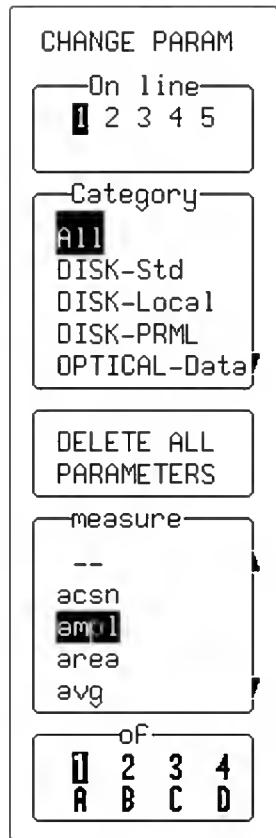
To determine the starting point, in screen divisions, for parameter measurements. “Track” “On”, links control of both the starting and end points of the parameter measurement so that they can be moved together using the associated menu knob.

##### to

To determine the end point in screen divisions.

## CHANGE PARAM

— for modifying parameters.



### On line

To select for modification up to five different parameters, "1", "2", "3", "4", or "5".

### Category

To specify the category of parameter. When "All" is selected, the "measure" menu (see below) will feature all parameters. However, when a particular category is selected, only those parameters in the category are shown.

### DELETE ALL PARAMETERS

For deleting all parameters previously selected.

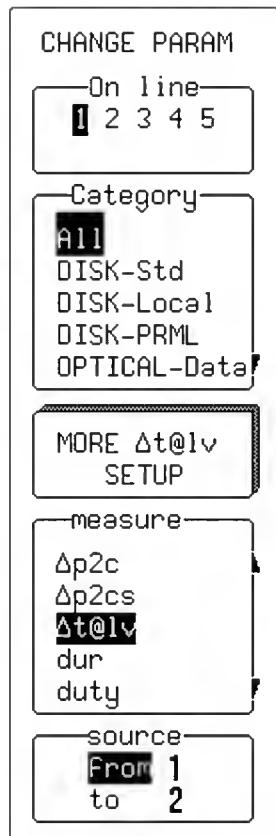
### measure

To choose the new parameter to be measured on this line. When "--" is selected the line is not used.

### of

For selecting the channel or trace on which the parameter will be measured (*four-channel menu shown*).

### CHANGE PARAM



Parameters can be customized to meet specific needs:

#### On line

To select for modification up to five different parameters, "1", "2", "3", "4", or "5".

#### Category

To specify the category or type of parameter.

#### MORE Δt@lv SETUP

Calls up the "Δt@lv" customization menu (*next page*).

#### measure

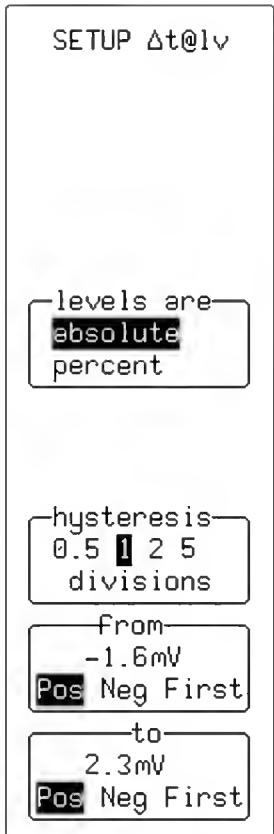
Set at Δt@lv.

#### source

Using the menu button, selects the channel — "1", "2" ("3" or "4") — or memory ("A", "B", "C", or "D"). While the knob selects "from" which and "to" which channel the measurement is to be made.

## SETUP

“ $\Delta t@lv$ ” — for customizing the  $\Delta t@lv$  parameter.



### levels are

For selecting whether the levels should be set in absolute or percentage of the peak-to-peak signal value.

### hysteresis

To set the hysteresis division. Hysteresis essentially enables the user to set a voltage band, which a waveform peak-trough pair must exceed in order not be considered either noise or a “bump”. This threshold crossing is recognized when an acquisition point in the waveform passes through the threshold level by 1/2 the hysteresis-division setting.

#### from

For selecting the voltage setting: the level on the trace at which the timing should start. And to select *where* the timing should start: “**Pos**” for rising edge, “**Neg**” for falling edge, “**First**” for either positive or negative edges.

#### to

For selecting the voltage setting: the level on the trace at which the timing should finish. And to select *where* the timing should finish: “**Pos**” for rising edge, “**Neg**” for falling edge, “**First**” for either positive or negative edges.

### SETUP

“Δc2d+” — for customizing the Δc2d+ parameter.



#### **hysteresis**

To set the hysteresis division. Hysteresis essentially enables the user to set a voltage band, which a waveform peak-trough pair must exceed in order not be considered either noise or a “bump”. This threshold crossing is recognized when an acquisition point in the waveform passes through the threshold level by 1/2 the hysteresis-division setting.

#### **clock edge**

To select the clock edge or edges used for this parameter measurement.

#### **data edge**

For selecting the data edge or edges used for the measurement.

## Pass/Fail Testing

Parameters can also be used in carrying out Pass/Fail tests. These tests require a combination of measurements within chosen limits, using an action provoked when the test either passes or fails, depending on which has been specified. Signals can also be Pass/Fail tested against a tolerance mask.

Up to five parameters can be tested against limits at the same time. And, in tolerance mask testing, a trace can be compared to a tolerance mask.

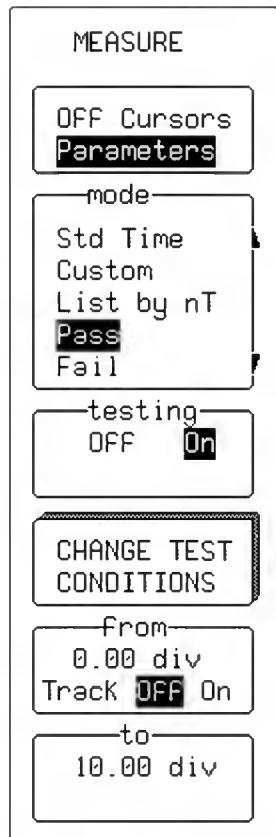
Whether the tests pass or fail, any or all of the following actions can be provoked:

- Stop capturing further signals
- Dump the screen image to a hardcopy unit
- Store selected traces to internal memory, to a memory card (*optional*), or to a floppy
- Sound the buzzer
- Emit a pulse on the CAL BNC.

The Pass/Fail display will show:

- Results on the current waveforms
- Number of events passing
- Total number of sweeps treated
- Actions to be taken.

### MEASURE — Parameters — Pass/Fail



#### Off/Cursors/Parameters

To select “Parameters”.

#### mode

To select “Pass” or “Fail”.

#### testing

For turning testing “Off” or “On”. Testing is turned off in order to observe only the parameter variations.

#### CHANGE TEST CONDITIONS

To access the secondary “CHANGE TEST” menu (*see next page*)

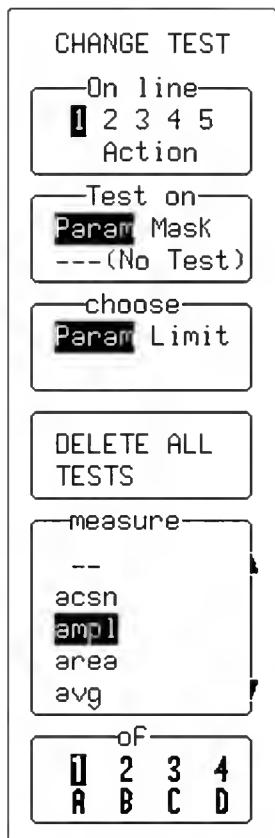
#### from

To determine the starting point, in screen divisions, for parameter measurements.

#### to

To determine the end point in screen divisions.

## CHANGE TEST



### On line

To select for modification up to five different parameters, “1, 2, 3, 4 or 5”

### Test on

To select “Param” or, if no test is required, “--- (No Test)”.

### choose

To select “Param”.

## DELETE ALL TESTS

For deleting all tests previously selected.

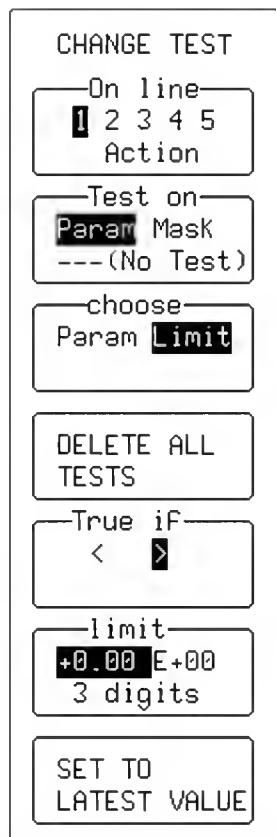
### measure

For selecting the new parameter to be measured on this line. When “--” is selected the line is not used.

### of

For selecting the channel or trace on which the parameter will be measured (*four-channel menu shown*).

### CHANGE TEST — Param (Changing Limits for Pass/Fail Tests on Parameters)



#### On line

To select for modification up to five different parameters, “1, 2, 3, 4 or 5”.

#### Test on

To Select “Param” or “--- (No Test)” if no test required on the selected line (“Mask” selection, page 14-17).

#### choose

For setting to “Limit” (“Param” 14-15).

#### DELETE ALL TESTS

For deleting all tests previously selected.

#### True if

For selecting the adequate relation — smaller than “<”, or greater than “>”.

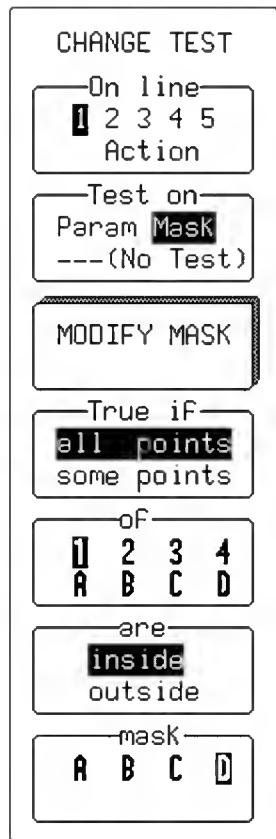
#### limit

To make the choice of one of three modifications of a limit: its mantissa, exponent, and the number of digits for the representation of its mantissa. The corresponding menu button is used to select, and the associated knob to modify the number in that field.

#### SET TO LATEST VALUE

To set the limit to the latest measured value — a starting value for the final adjustment.

## CHANGE TEST — Mask (Changing Pass/Fail Test on a Mask)



### On line

To select for modification up to five different parameters, “1, 2, 3, 4 or 5” (“Action” selection, page 14-20).

### Test on

For setting to “Mask” or “--- (No Test)” if no test required on the selected line (“Param” 14-15).

### MODIFY MASK

To access the secondary menu for modifying mask settings.

### True if

For choosing this mask-test condition.

### of

To select channel or trace for testing (four-channel menu shown).

### are

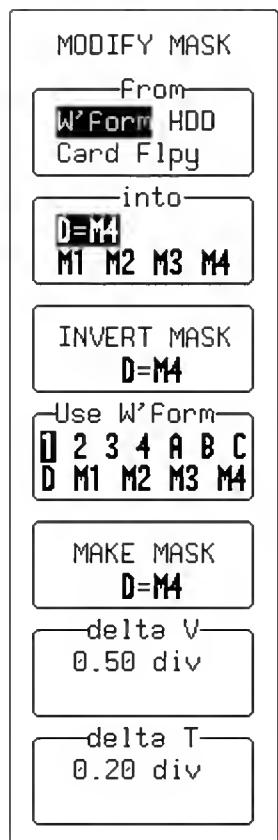
For choosing this mask-test condition.

### mask

To select mask trace “A”, “B”, “C” or “D”.

**Note:** Pass/Fail testing against a mask is affected by horizontal and vertical zooming of the mask trace. The test will be made inside the area bordered by the parameter cursors. Timebases of the mask and the trace under test should be identical. For visual mask testing, a single-grid display should be used when performing a single-trace mask test, while a dual- grid display should be used for a dual-trace test.

### MODIFY MASK — W'form (Generating a Mask from a Waveform)



#### from

To select "W'form".

#### into

For selecting "D=M4" if the mask is to be automatically displayed on the screen Otherwise select "M1", "M2", "M3", or "M4".

Using "RECALL W'FORM" (see previous chapter) memories M1–M4 can be recalled to traces A to D for display.

#### INVERT MASK

To generate an inverted mask.

#### Use W'form

For selecting the waveform to be used as reference. The mask will be generated around this waveform (four-channel menu shown).

#### MAKE MASK

To generate the mask.

#### delta V

For selecting tolerance in amplitude, using the attributed knob.

#### delta T

For selecting tolerance in time, using the attributed menu knob.

**MODIFY MASK****(FLOPPY DISK OR OPTIONAL STORAGE DEVICE)****from**

To select the device.

**into**

For selecting "D=M4" to automatically display the mask on- screen, or "M1", "M2", "M3" or "M4".

**INVERT MASK**

For generating an inverted mask.

**DO RECALL**

To recall the mask.

**File**

To select the appropriate mask, using the associated menu knob.

### CHANGE TEST — Action (Setting PASS/FAIL Actions)

Depending on the test result certain actions can be taken.



#### On line

For selecting "Action".

#### DELETE ALL ACTIONS

To delete all previously selected actions.

#### If

To determine if the action will be taken on "PASS" or "FAIL".

#### Then

For selecting the action ("Dump" in this example). The selected action will then be activated in the menu below.

#### Dump

To perform ("Yes") or disable ("No") the action chosen in the "Then" menu (see above). The choice will then be indicated alongside the already selected action in "Then".